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Schnizler, Jr.

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[54] **HAMMER DRILL**

[75] Inventor: **Albrecht Schnizler, Jr.,** Nurtingen, Germany

[73] Assignee: **Metabowerke K.G., Closs, Rauch & Schnizler,** Nurtingen, Germany

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[58] **Field of Search** 173/104, 117

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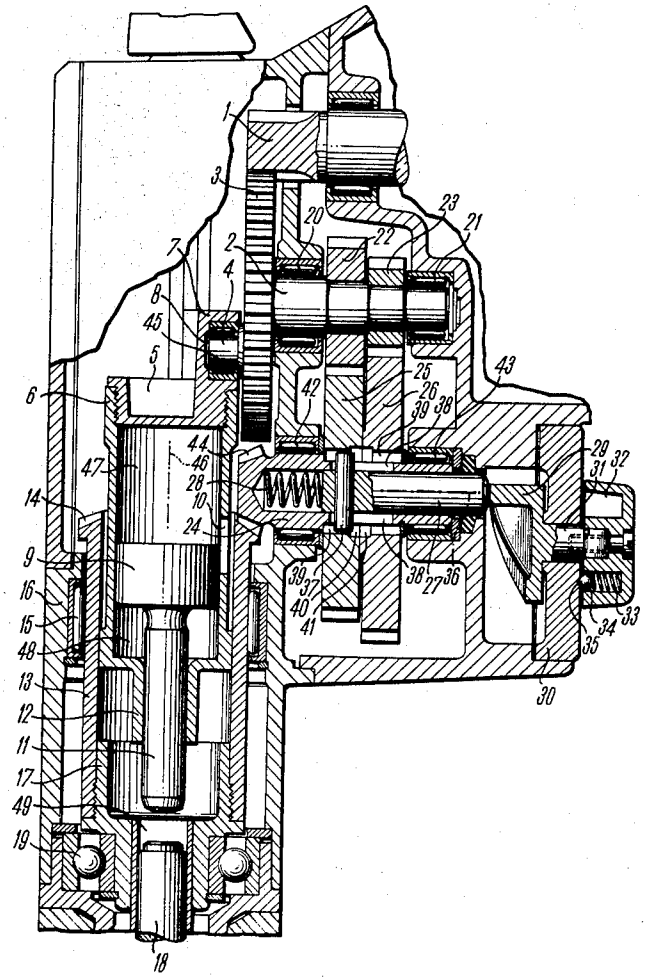
Primary Examiner—James A. Leppink

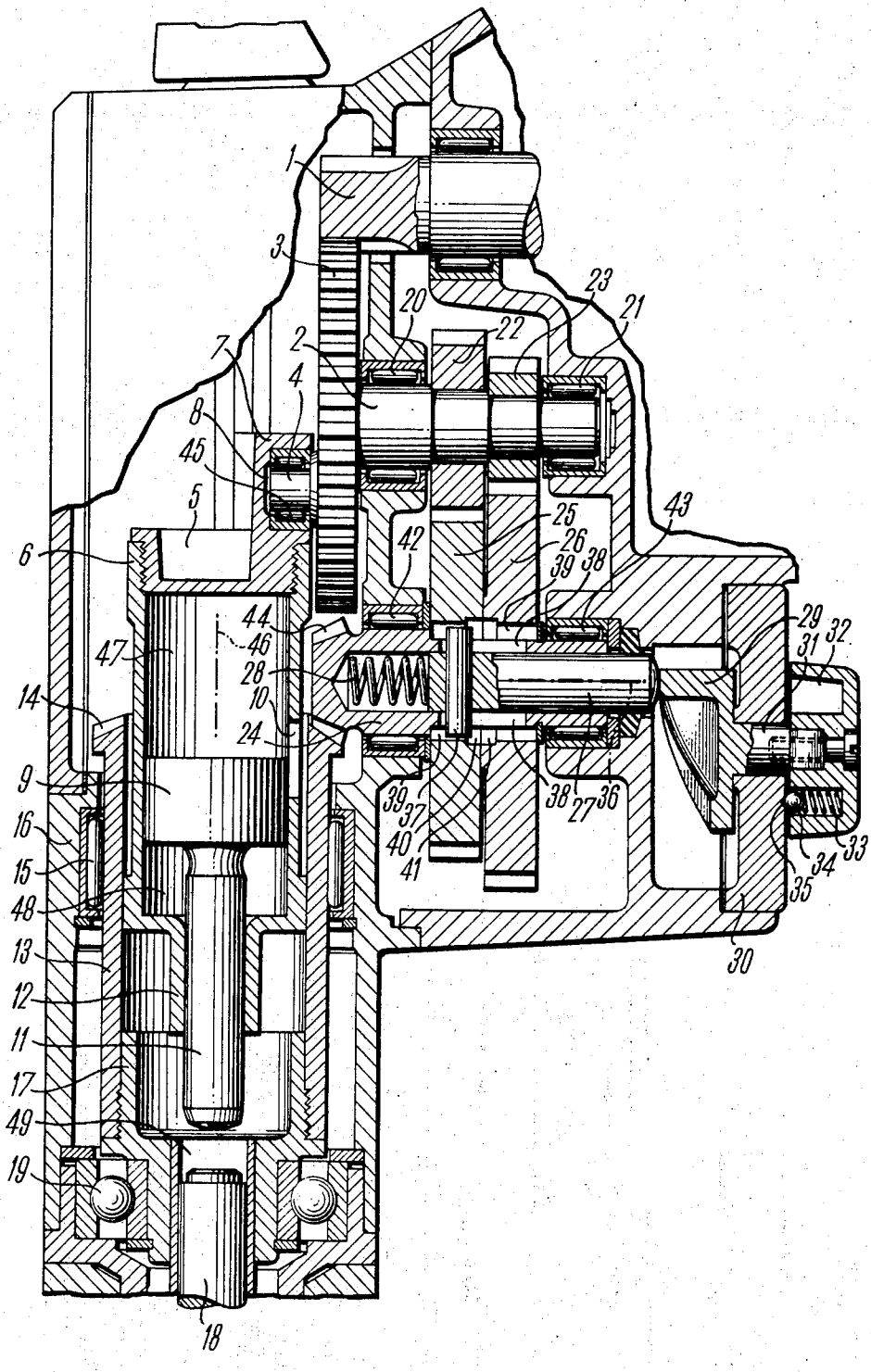
Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

A percussion or hammer drill with a gear unit which is preferably driven by an electric motor and permits the ratio between the speed of rotation of the drilling tool and the frequency of the impacts of the striker upon this tool to be varied.

14 Claims, 1 Drawing Figure

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HAMMER DRILL

The present invention relates to a percussion or hammer drill which is operated by a motor driven gear unit which comprises first gear elements for effecting the rotary movement of the drilling tool and second gear elements for reciprocating a striker in the axial direction of the tool so as to exert impacts upon the drilling tool.

The known machines of this type have the disadvantage that, when operating such a machine with a drilling tool of a large diameter, the reduction in speed of the motor caused by the greater load also results in a considerable reduction of the frequency of the impacts of the striker upon the tool and also of the speed of rotation of the tool. Although when using a tool of a larger diameter a lower speed of rotation of this tool is usually desirable, the simultaneous reduction of the frequency of the impacts of the striker upon the tool reduces the drilling efficiency and the output of the machine. These known machines also do not permit the speed of rotation of the drilling tool to be adjusted in accordance with different kinds and degrees of hardness of the materials to be worked upon. If such a machine is used with a tool of a small diameter, the speed of rotation of this tool is often too low so that the cuttings will not be discharged sufficiently from the bore while being drilled which has the result that the tool may jam in the bore hole and at least cause its speed to drop considerably. The tool must then be frequently pulled out of the bore hole to remove the cuttings. This frequent jamming and withdrawal of the tool from the bore hole, of course, reduces the work output of the machine considerably.

It is an object of the present invention to provide a percussion or hammer drill which is capable of operating very efficiently without interruptions on materials of different kinds and different degrees of hardness by means of tools of different diameters.

For attaining this object, the present invention provides that the ratio between the speed of rotation of the drilling tool and the frequency of the impacts of the striker upon this tool is adjustable, preferably by control means which may be operated on the outside of the machine. Since it is desirable that the frequency of the impacts upon the tool remains constant, the invention provides a percussion or hammer drill which comprises a gear which is driven by a pinion on a motor shaft and carries a crankpin for reciprocating a cylinder containing a piston which carries the striker. According to the invention, the frequency of this striker upon the drilling tool remains constant and the machine is provided with a change-speed gear which is driven by a first shaft carrying the gear with the crankpin and is adjustable by simple control means at the outside of the machine so as to permit the drilling tool to be rotated at different speeds. The first shaft is for this purpose provided with at least three gears and a second shaft with a pinion and at least two additional gears of different diameters adjacent to each other and meshing with two of the gears on the first shaft. For easily manufacturing and assembling the elements of this machine and for easily changing the gears for rotating the drilling tool at different speeds, the second shaft is made of a tubular shape and contains a control rod and a compression spring which acts upon the control rod in its axial direction so that its end which projects from the second shaft presses

against an adjustable cam. The control rod is provided with a pin which extends transversely to its axis and projects through and is slidable along elongated slots in the wall of the second shaft. The opposite ends of this pin engage into diametrically opposite recesses in the walls of the central bores of the two gears on this second shaft, and depending upon the adjustment of the control means and of the control pin within the tubular second shaft, this pin connects either one or the other gear to this shaft so as to drive the same at one speed or another.

According to one preferred embodiment of the invention in which the striker is slidable in its axial direction within a cylinder containing an air-cushioned piston carrying the striker, and in which the upper end of this cylinder is closed by a cover, the machine may be made of a flat shape by providing this cover at one side above the cylinder with an extension containing an aperture for receiving the bearing of the crankpin.

For reducing the wear upon the reciprocating cylinder this cylinder is located concentrically within and slidable along the inner wall of a guide tube. This guide tube carries on its upper end a rim of bevel teeth which are in engagement with the bevel pinion on the second shaft, while the other end of this guide tube carries a tool holder which is adapted to receive a drilling tool. Near its upper end which is provided with the rim of bevel teeth and also near the tool holder, the guide tube is rotatably mounted in needle or roller bearings.

The features and advantages of the present invention will become further apparent from the following detailed description thereof which is to be read with reference to the accompanying drawing which shows a cross section of the principal elements of one preferred embodiment of the percussion drill according to the invention.

As illustrated in the drawing, the machine according to the invention comprises a drive pinion **1** on the shaft of an electric motor (not shown) which meshes with a gear **3** which is secured at one side to a first shaft **2** and carries on its other side a crankpin **4.** A cover **5** which closes the upper end of a cylinder **6** is provided at one side with an upwardly projecting side wall **7** which has an oblong recess **8** in which the needle bearing **45** for the crankpin **4** is slidably mounted. Cylinder **6** the wall of which is provided with an aperture **10** contains a striker piston **9** which is adapted to reciprocate in its axial direction within this cylinder and carries a striker **11** which projects through and is guided by the downwardly projecting neck-shaped bottom **12** of cylinder **6.** A tubular guide sleeve **13** in which cylinder **6** is axially slidable as provided on its upper end with a rim of bevel gear teeth **14** and is rotatably mounted underneath these teeth within a needle bearing **15** in a housing **16.** The lower end of guide sleeve **13** is closed by tool holder **17** which is mounted within a ball bearing **19** in the housing **16** and is adapted to receive a drilling tool **18.**

The first shaft **2** which is rotatably mounted in a pair of needle bearings **20** and **21** in the housing **16** carries near the center of its length two gears **22** and **23** of different diameters or a larger number of different gears if the gear unit is designed for more than two speeds. These gears **22** and **23** which are rigidly secured to the shaft **2** mesh with the gears **25** and **26** which are rotatably mounted on a second shaft **24** which has a tubular shape. Along the inner wall of this shaft **24** a control

rod 27 is axially slidable which is pressed by a compression spring 28 against a cup-shaped cam member 29 the peripheral wall of which varies in height. This cam member 29 is secured to or integral with a short shaft 31 which is rotatably mounted in a cover 30 and carries on its end a control knob 32 which is provided with a locking device consisting of a ball 34 which is acted upon by a compression spring 33 and is adapted to engage into one or another of a plurality of shallow recesses 35 in the cover 30. Transversely to its axis 36, the control rod 27 carries a pin 37 the opposite ends of which project through diametrically opposite longitudinal slots 38 in the wall of the tubular shaft 24 and are adapted to engage into grooves 39 in one or the other gear 25 and 26. The sides of gears 25 and 26 facing each other are each provided with an annular recess 40 or 41 so that, when pin 37 is located centrally between the two gears, these gears may rotate freely without taking along the second shaft 24 which is rotatably mounted near its opposite ends within needle bearings 42 and 43 in parts of the housing 16. The closed end of the second shaft 24 forms a bevel pinion 44 which meshes with the bevel gear teeth 14 on the upper end of guide sleeve 13.

When the machine is in operation, the drive pinion 1 on the shaft of the motor drives the gear 3 whereby the crankpin 4 which projects from this gear and is mounted in the needle bearing 45 in the cover 5 of cylinder 6 reciprocates the latter together with the striker 9 in the direction of the axis 46. The needle bearing 45 is for this purpose slidably mounted in an oblong recess 8 of cover 5 so as to be able to oscillate vertically to the axis 46 and to the plane of the drawing. Separated by air cushions 47 and 48 from the opposite ends of cylinder 6, piston 9 then reciprocates in the direction of the axis 46 and its striker 11 thereby hits against the upper end of the tool 18 if the latter projects sufficiently into an axial bore 49 in the tool holder 17.

At the same time, by means of gear 3 and the gears 22 and 23, the gears 25 and 26 are driven at different speeds in accordance with their different diameters. Depending upon whether pin 37 is located within the grooves 39 in gear 25 or in gear 26, the second shaft 24 will be driven either at a higher or lower speed. If pin 37 is located in its central position and thus in the adjacent annular recesses 40 and 41 in gears 25 and 26, the second shaft 24 will not be driven. Pin 37 may be adjusted from the outside to the desired positions by turning the control knob 32 and the cam member 29 thereon. Tool 18 will then be rotated at one speed or the other by the bevel pinion 44 on shaft 24, the rim of bevel teeth 14 on guide sleeve 13, and the tool holder 17.

It is within the concept of the invention that equivalent parts may be employed in place of those described and illustrated and that, for example, in place of a change-speed gear transmission an infinitely variable transmission may be employed, for example, one of a friction wheel type.

The advantages which are attained by the present invention are due particularly to the fact that the speed of rotation of the drilling tool may be adjusted so as to be the most suitable depending upon the type and degree of hardness of the material to be worked upon and upon the diameter of the tool. The machine according to the invention has the further advantage that it is of a very simple and sturdy construction and capable of withstanding rough treatment.

Although my invention has been illustrated and described with reference to the preferred embodiment thereof, I wish to have it understood that it is in no way limited to the details of such embodiment but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. A hammer drill comprising a housing; tool holding means rotatably mounted at least partly in said housing for holding a drilling tool; striking means mounted in said housing for reciprocating movement in the direction of the axis of said tool and adapted to intermittently exert impacts at least indirectly upon said tool so as to move the same in axial direction relative to said housing; a gear unit in said housing; means for driving said gear unit and comprising a driven shaft and a drive pinion secured to said driven shaft, said gear unit comprising first gear means comprising a first shaft rotatably mounted in said housing, a gear secured to said first shaft and engaging with said drive pinion and having a crank pin on one side thereof connected to said striking means for reciprocating the same in said axial direction, said gear unit further comprising second gear means comprising a plurality of gears of different size secured to said first shaft, a second shaft rotatably mounted in said housing, a plurality of gears on said second shaft, normally freely rotatable thereon and respectively meshing with associated gears on said first shaft, and transmission means for transmitting the rotation of said second shaft to said tool holding means; and control means for varying the speed of rotation of said tool holding means and thereby the ratio between said speed of rotation and the impacts of said striking means, said control means comprising movable connecting means within said housing for selectively connecting one or another of said gears on said second shaft so as to be rotatable therewith, and means adapted to be operated on the outer side of said housing for controlling the movements of said connecting means in said housing.

2. A hammer drill as defined in claim 1, in which said striking means comprise a cylinder, an air-cushioned piston within said cylinder having a striker rod secured to said piston and projecting from said cylinder, guide means for guiding said cylinder so as to be movable in said axial direction, and bearing means on said cylinder for receiving said crankpin and for operatively connecting the same to said cylinder.

3. A hammer drill as defined in claim 2, in which said guide means comprise a tubular member in which said cylinder is slidable in said axial direction, and bearing means for mounting said tubular member within said housing so as to be rotatable about an axis extending substantially parallel to said axial direction, said transmitting means comprising a bevel pinion on one end of said second shaft and a rim of bevel teeth on the upper end of said tubular member and meshing with said bevel pinion.

4. A hammer drill as defined in claim 3, in which said tool holding means is secured to the lower end of said tubular member and said tool is slidable in said axial direction within but nonrotatable relative to said tubular member and its upper end is adapted to be struck by said striker rod.

5. A hammer drill as defined in claim 2, in which said cylinder has a bushing secured to its end facing said tool, said striker being slidable substantially air-tight along said bushing, and a cover removably secured to and tightly closing the other end of said cylinder so that an air cushion is formed at both sides of said piston within said cylinder, said cover having a lateral extension on its outer side and a short oblong recess in said extension, and a needle bearing for said crankpin slidable within said recess during the rotation of said gear carrying said crankpin.

6. A hammer drill as defined in claim 1, in which each of said gears on said second shaft has a central bore through which said second shaft extends so as normally to be freely rotatable therein, the wall of said second shaft having diametrically opposite longitudinal slots therein and the wall of each of said bores having diametrically opposite grooves therein, said second shaft being at least partly tubular, said control means comprising a control rod axially slidable within said second shaft, a pin extending transversely through said control rod and having ends projecting therefrom through said longitudinal slots in the wall of said shaft into said grooves of a first of said gears on said second shaft so as to lock said first gear to said second shaft to drive the same while the adjacent gear on said second shaft continues to be freely rotatable on said second shaft, a compression spring within said second shaft acting upon one end of said control rod and tending to shift said rod within said second shaft so that said pin slides out of said grooves of said first gear and into said grooves of the adjacent gear so that said second shaft will then be driven by said adjacent gear while said first gear is freely rotatable, and means engaging upon the other end of said control rod against the action of said spring and manually movable on the outside of said housing for shifting said rod with said transverse pin from the grooves in one of said gears to the adjacent gear on said second shaft and for thus changing the speed of rotation of said tool holding means.

7. A hammer drill as defined in claim 6, in which said gears on said second shaft are located closely adjacent to each other, said bore of each of said gears having an annularly enlarged end adjacent to the corresponding annularly enlarged end of the bore of the adjacent gear whereby, when said control rod is shifted so that said transverse pin slides out of said grooves in one of said gears on said second shaft in the direction toward said grooves of the adjacent gear, said pin enters said enlarged parts of said bores of said adjacent gears and said adjacent gears are therefore freely rotatable on said second shaft.

8. A hammer drill as defined in claim 6, in which said manually movable means comprise a curved cam member within said housing engaging upon said other end of said control rod, and a control knob on the outside of said housing and connected to said cam member for moving the same.

9. A hammer drill as defined in claim 8, in which said cam member is substantially cup-shaped and has a central pin projecting from the bottom thereof through a bore in the wall of said housing, said control knob being connected to the outer end of said central pin, the peripheral wall of said cam member gradually varying in height from said bottom.

10. A hammer drill as defined in claim 9, in which the part of the wall of said housing covered by said knob has a plurality of recesses spaced from each other and each associated with one of said gears on said second shaft, and resilient means in said knob adapted to engage into either of said recesses when said knob is turned accordingly so as to lock said cam member and said control rod in the adjusted position.

11. A hammer drill comprising a housing; tool holding means rotatably mounted in said housing for holding a drilling tool; striking means mounted in said housing reciprocatable in the direction of the axis of said tool and adapted to intermittently exert impacts at least indirectly upon said tool so as to move the same in said axial direction relative to said housing; a motion-transmitting unit in said housing; means for driving said motion-transmitting unit, said motion-transmitting unit comprising first motion-transmitting means for reciprocating said striking means in said direction and second motion-transmitting means for rotating said tool holding means about said axis and comprising a coupling shaft in permanent driving engagement with said tool holding means, first and second gears permanently coupled with said drive means, and coupling means shiftable between a first end position connecting one of said gears to said coupling shaft for driving the latter at a first speed and a second end position connecting the other of said gears to said coupling shaft for driving the latter at a second speed; and control means cooperating with said coupling means for shifting the same between said positions thereof so as to vary the speed of rotation of the tool holding means and thereby the ratio between the speed of rotation and the frequency of the impacts of said striking means.

12. A hammer drill as defined in claim 11, wherein said coupling means is shiftable by the control means also to an intermediate position between said two end positions in which neither of said gears is connected to said coupling shaft.

13. A hammer drill comprising a housing; tool holding means rotatably mounted in said housing for holding a drilling tool; striking means mounted in said housing for reciprocating movement in the direction of the axis of said tool and adapted to intermittently exert impacts at least indirectly on said tool; gear means in said housing for rotating said tool holding means at variable speeds, said gear means including a first shaft rotatably mounted in said housing; a driven shaft rotatably mounted in said housing; a pinion fixed to said driven shaft; a gear fixed to said first shaft and meshing with said pinion; and a crank pin on said gear and connected to said striking means for reciprocating the same in said axial direction.

14. A hammer drill as defined in claim 13, wherein said gear means further comprises at least two additional gears of different diameters mounted on said first shaft for rotation therewith, a second shaft rotatably mounted in said housing, at least two further gears normally freely rotatable on said second shaft and respectively meshing with said gears on said first shaft, and operator controlled coupling means for selectively coupling any of said further gears to said second shaft for rotation therewith; and including a drive connection between said second shaft and said tool holding means.

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